Distributed Generation Challenges: Air Quality, Siting, Permitting

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There are several environmental, engineering, and social issues that affect successful siting of distributed generation. Distributed generation (DG) sources (sources ≤20 MW) include technologies such as fuel cells, photovoltaics, reciprocating internal combustion engines, small- and micro-turbines, and wind power. Addressing issues prior to equipment operations can include obtaining siting, construction, and operating approvals from multiple regulatory and governmental agencies, as well as possibly undergoing public review and scrutiny. The level of agency involvement is typically dependent on the extent of a DG source's environmental impact. Specific siting issues can arise that may result in project start-up delays, costly permitting, and project cancellation. These issues must be addressed in the early stages of project development.

This article presents an overview of the various siting issues, possible approaches to minimizing the uncertainty in the approval process, and examples of distributed generation projects, with particular emphasis on air quality permitting requirements. Emerging regulatory, policy and technology trends are also highlighted, where applicable.

INTRODUCTION: SITING ISSUES

With the on-going electric utility restructuring, distributed generation (DG) is being positioned in the marketplace as an option for the traditional central power plant energy suppliers, as well as a source of reliable and cost-effective energy supply. Since January 1998, when the California Alliance for Distributed Energy Resources (CADER) published its report "Collaborative Report and Action Agenda," there have been numerous regulatory initiatives and the emergence of several organizations focused on the market placement of DG.

Efforts include: programs developed by U.S. Department of Energy that focus on DG technologies, focused attention on interconnection standards by the Institute of Electrical and Electronics Engineers and by various state public utility commissions, and legislative initiatives to address air quality issues associated with fossil fuel-fired DG sources. Recent states' efforts include the collaboration of joint air quality and energy agencies; California and Texas are currently engaged in such efforts.

The issue of air quality impacts is particularly critical within the context of fossil fuel-fired technologies, as well as those DG technologies that may directly replace or displace fossil fuel-fired technologies. Air quality requirements and procedures vary from state-to-state. Because permit requirements are dependent on emissions impacts, the type of DG technology and application will determine the complexity of permitting. As expected, developers installing higher emitting equipment will undergo more regulatory scrutiny.

Overview of Siting Issues for Project Planning

Distributed generation technologies are small electrical power generation sources that are generally ≤20MW. DG technologies that are currently available include fuel cells, photovoltaics, reciprocating internal combustion engines, small- and micro-turbines, and wind power. The equipment may serve emergency standby needs, peak power demands, intermittent needs and/or base load operations. Depending on the technology, the equipment may be used to generate electricity or in a combined heat and power application. For all DG technologies, a building permit is necessary.

Depending on the potential environmental impacts and the geographic location of the proposed DG project, land use issues and air quality issues may also need to be addressed.

The issues affecting DG siting and permitting include environmental, energy, and social issues. **Environmental issues** include regulated media, plan or permit approvals, and compliance mandates; **energy issues** include engineering considerations; **social issues** include community concerns and economic considerations.

Environmental issues that are typically associated with fossil fuel-fired DG sources include air quality, land use, hazardous materials/waste, aesthetics/visuals, and noise. The primary energy issue is interconnection and, to a lesser extent, the need for the additional capacity. The primary social issues include environmental equity/justice and "NIMBY-ism" (not-in-my-back-yard).

Given the variety of issues to address, project complexity is added by the fact that approvals must be obtained by various local (county, city) agencies, as well as the need to work with the local distribution company in order to ensure proper and safe interconnection. Additionally, depending on site selection, nearby residents and other businesses may be involved in public review and comment of a DG installation.

As an example, in California, there are 58 counties, 35 air districts, energy plans in 17 counties, energy plans in 28 cities, 13 local permit assistance centers supported by the state environmental agency, and 10 fire marshal branch offices dispersed through 3 regions.

Consequently, planning for development in the northern portion of the state can differ greatly for development in the southern portion of the state. Differences may include extended review/approval periods, greater involvement of the local planning community, interconnection standards, and compliance requirements.

Agency Environmental Review and Permit Streamlining

Currently, the California Energy Commission (CEC) is addressing siting issues for DG sources. Although the CEC does not have permitting jurisdiction over DG sources, the CEC is tasked, through a formal rulemaking effort by the California Public Utilities Commission, to investigate DG review and streamlining options. (The California Air Resources Board is also actively involved in this effort with the CEC.) The intent is not to change the approval processes but to identify mechanisms to streamline the processes. As a result of the CEC's initial Siting Committee Workshop, key issues have been identified, along with potential solutions and a rationale for why the potential solution would resolve a particular issue.

As part of the CEC's workshop report, issues and potential solutions were identified. Although process issues and potential solutions are directed at siting in California, several of the issues also exist in other states' review processes. These include lack of knowledge of DG technologies, unclear requirements and agency procedures, and the lack of a comprehensive source of information regarding DG technologies impacts.

The CEC identified potential solutions to issues and problems associated with DG installations. These include the development of guidance documents, databases of DG technologies and environmental profiles, uniform standards and codes, legislative actions to clearly outline applicable requirements, educational outreach efforts, and pre-certification of select technologies.

While issues have not yet been resolved and potential solutions have not been implemented, it is expected that those potential solutions formally recommended for adoption will facilitate the streamlining of the approval process for DG installations. It is likely that the ultimate outcome of the CEC's efforts may shape other states' efforts to address DG installations. Meanwhile, the following offers an approach to addressing an agency's approval process.

PROJECT PLANNING ELEMENTS: PREPARE, EXECUTE, COMMUNICATE

Whether a DG source is chosen for a particular facility will depend on several facility operations considerations. Generally, this will include an evaluation of the energy and economic trade-off such as electric rates, fuel efficiencies and costs, operating hours, load and capacity, and environmental costs.

As part of this evaluation, air quality and other siting issues will be considered as part of the economic savings (or burden) to a facility. For example, for a base load operation, one of the more obvious costs is the potential for add-on control technology to minimize air pollutant emissions in order to meet agency standards; operating fewer hours per year may eliminate the need to install costly controls.

However, because requirements vary from agency to agency, understanding what requirements must be met involves planning in order to reduce the potential for project delays. In order to minimize the uncertainty associated with DG source installation approvals, a three-part approach is suggested—**prepare**, **execute**, and **communicate**. Each is briefly described below.

Prepare: Understanding the Issues, Agencies and Regulations

Prior to formally proposing a DG installation to local agencies, it is necessary to identify potential siting and environmental issues, the direct (and oversight) approval agencies, and the applicable regulatory requirements. Additionally, at this stage in project planning, potential environmental impacts/consequences should also be identified in the event that it will be necessary to mitigate or control such impacts.

Typically, this may mean add-on controls, reducing operating hours, reconfiguring or redesigning the facility layout, or even providing for additional support in local community development to offset an impact.

One of the most overlooked factors in project preparation is consideration of the affected local community and their acceptance or rejection of a DG installation. For example, for inside the fence operations at an existing facility, there may be little to no community involvement.

However, for new sites in a residential area, there is a high likelihood of at least community curiosity and a greater likelihood of community outrage if the community has not been properly informed about the DG installation plans.

As outlined in Peter Sandman's publication, there are nine public members that may be involved in community input and present differing perceptions and concerns.[1] These members include: industry, regulators, elected officials, activists, employees and retirees, neighbors (especially those directly impacted), concerned citizens, experts (e.g., scientists), and the media.

In short, preparation of the rollout of a DG project should involve identifying potential public members in order to minimize or eliminate project rejection.

Execute: Scoping, Information Compilation and Doing Your Homework

As part of the project execution, it is necessary to scope out the issues and barriers in order to develop contingencies to overcoming potential issues and barriers. This involves a more thorough evaluation of the information gathered in the preparation stage.

For example, given a relatively significant (real or perceived) air quality impact of the DG source, if the source is sited in a minority or low income neighborhood with an existing disproportionate burden of air pollutant impacts, not only will the need for potential add-on controls be an issue but public outrage may need to be addressed. As a result, control options should be identified.

Such project development may be viewed as an environmental justice issue. A public affairs and communication protocol is one approach to minimizing public concern.

With respect to compiling information, given the multi-agency involvement and different approval criteria and review time frames, the appropriate approval process, forms, fees and necessary equipment/operations information should be identified and completed.

One approach is to work closely with the approval agency prior to any application submittal. This can greatly streamline the approval process and minimize project delays.

Therefore, upon application submittal, assuming all information has been compiled and presented based on pre-application discussions, an agency can more readily review the project and issue the necessary approval.

Finally, given that many agencies' actions are through public entities, it is best to take advantage of "lessons learned" by other DG project efforts. At a minimum, agencies' records can be petitioned for review and copy. Such records may include the application content of another DG source, as well as the agency's evaluation criteria and conclusions.

Moreover, for many DG equipment manufacturers and/or developers, the first-hand experience may provide insight to the hurdles that were overcome in the siting of their particular DG source.

Communicate: Target Audience, Common Language and Compromise

Throughout project planning and execution, it is necessary to understand the target audience. As noted in the preparation stage, agencies and public members should be identified with emphasis on those parties that may pose questionable issues and barriers.

Although it is not necessary to undertake an extensive public affairs effort for certain types of DG installations, it is necessary to understand what information should be readily available in order to properly characterize and present a project. The objective for identifying the target audience is to gain project acceptance.

Too often the characterization of a project is in technical terms, e.g., engineering, operations, chemical names, etc. By doing so, affected agencies and public members may be more confused rather than properly informed by what is an accurate description of the DG project. During the execution stage, preparing information that "speaks" to the affected parties can greatly minimize confusion, resulting in a more streamlined review and understanding of project benefits.

For example, when discussing issues with an air quality agency, estimated emissions and project operations that may affect emissions should be the focus of discussion. When discussing air quality impacts with the public, comparisons of emissions that may be associated with known emitting operations can be helpful; this may include a comparison with other power generation facilities or even a comparison of the number of vehicles that may have the same emissions impact.

Finally, as part of project impacts communication, negotiation strategies should be developed in order to address potential regulatory (and public acceptance) barriers. As part of the air quality permitting approval process, permit conditions will likely be a key area for negotiations.

This includes negotiating record keeping requirements, operating hour limitations, monitoring requirements and emission limits. With respect to addressing public concerns, having scoped out issues and barriers should facilitate identifying those project mitigation options as part of public acceptance.

AIR QUALITY PERMITTING AND REGULATORY ISSUES: PROJECT CONSIDERATIONS

There are several considerations with respect to air quality regulatory compliance issues:

- **Exemption/permit thresholds—whether a DG source triggers permit requirements**. Permit exemption levels may exist for relatively small, low emitting operations; for example, gas turbines less than 0.3 MW are exempt from permitting in several California air districts. Likewise, sources with emissions less than 5 tons per year may be exempt.

- **Regional air quality—whether the site is in an attainment or nonattainment area**. Sites in nonattainment areas (e.g., areas where a pollutant concentration exceeds an ambient air quality standard) have more rigorous permitting requirements.

- **Facility/site characteristics—whether the site is an existing or new facility that is considered a minor or major source**. The addition of a source to an existing major source (e.g., "major" as defined by an air agency is based on a site's total tons per year emissions) can result in more rigorous permitting requirements.

- **Project/equipment composition—whether there is one unit or multiple units at a site**. Cumulative emissions impact of multiple units may need to be considered in the permit evaluation versus the impact of each individual DG unit.

- **Emissions impact—whether criteria and air toxic pollutants have an impact on nearby communities**. Air quality modeling or the evaluation of public health impacts may be required, particularly for diesel fuel fired operations.

Exemption/Permit Thresholds

Air quality agencies generally have a rule that lists specific equipment and processes that do not require a construction and/or operating permit. Thresholds may be based on MMBtu/hr, hp, MW or an emissions rate (e.g., lbs/hr, lbs/day, tons/year).

Likewise, exemptions may exist for the function of a DG unit (e.g., emergency standby generators) or the type of DG unit (e.g., fuel cells). Generally, permit exempt equipment are not subject to add-on controls and emission offset requirements.

However, some basic level of control of pollutants is required. For example, diesel engines may be required to use fuel injection timing retard, turbocharging, and/or aftercooling. It should be noted that for some state agencies, although a DG source may qualify for an exemption from formal permitting, it may still be necessary to notify the agency regarding the equipment installation or to obtain a construction approval or registration.

Regional Air Quality

For areas that are deemed nonattainment, New Source Review (NSR) permitting can apply. Depending on the magnitude of emissions, this can mean the requirement to install add-on controls, the conduct of an air quality modeling analysis of pollutant impacts, and/or the purchase of emission offset credits. In attainment areas, Prevention of Significant Deterioration (PSD) permitting can apply; this effort is generally less rigorous than NSR permitting. Typically, DG sources do not emit pollutants that would trigger PSD permit requirements.

Facility/Site Characteristics

If a DG source is added to existing site, the additional emissions must be added to the existing site's emissions. More complex permitting can result depending on whether a site is considered an existing "major" source or "minor" source.

Again, the definition of major and minor, typically an emissions thresholds in tons per year, differs from agency to agency. The resulting permitting impact can be the need to modify an existing facility permit for a major source. Although the addition of DG source to a major source is not a fatal flaw to project development, compliance requirements may be restrictive, and modifications to the existing permit may be necessary.

Project Equipment/Composition

Similar to the consideration of facility/site characteristics, it is necessary to properly define a "project" within the context of the total DG sources' emissions contribution and within the context of an agency's definition of "project." That is, for DG installations that may be composed of several DG units, it is likely that the cumulative impact of several DG units must be evaluated rather than addressing each unit's impact.

An example of this is the installation of several generators or small turbines at a campus setting. Although such equipment may be "phased-in" over the course of several months, the total emissions of the "project" must be considered. Otherwise, an agency may deem the "phase-in" of installations as circumvention of the permit process, if in fact a developer has incrementally installed units and has addressed each unit's impact separately and apart from other unit's emissions.

It should be noted that the treatment of the incremental (or one-time) installation of several permit exempt units may be addressed differently from agency to agency, and exempt units may not be subject to agency review.

Emissions Impacts

Finally, as discussed in the preceding air quality considerations, emissions impacts are core to the involvement of an air quality agency's permitting and compliance role. Regulatory permit thresholds are based on lbs/hr, lbs/day, and tons/year; in some cases, emissions over a calendar quarter may also serve as a regulatory threshold.

In short, for relatively larger operations (such as base load operations) in nonattainment areas, air quality modeling may be necessary not only for regulated criteria pollutants (e.g., NO_x, CO, SO_x, PM10, VOCs)[3] but for air toxics.

The issue of air toxics has become more prevalent since the Clean Air Act Amendments of 1990. Several by-products of combustion are characterized as air toxics and/or hazardous air pollutants. This can include formaldehyde, benzene, polycyclic aromatic hydrocarbons, and trace metals, such as those found in diesel fuel exhaust.

As a result, a health risk assessment that involves air quality modeling and an analysis of public health impacts may be required.

AIR QUALITY PERMITTING EXAMPLES

The following presents examples of air quality permitting for certain DG applications that are fossil fuel-fired: non-air pollutant emitting DG sources (e.g., photovoltaics, wind) do not require air quality permits, and fuel cells are typically exempt because of their insignificant emissions.

Because air quality thresholds differ from agency to agency and the permitting process may also differ from agency to agency, the intent of the various examples is to provide a general understanding of permitting issues, regulatory considerations and possible hurdles to overcome. Examples include the installation of a diesel emergency generator engine installation, gas engine, microturbine, small industrial turbine, or replacement of existing boiler operations with an internal combustion unit.

Emergency Generator Engine Installation

As previously noted, some types of equipment and operations may be exempt from permitting based on capacity, throughput and/or potential emissions. Most agencies have special provisions for emergency standby equipment. Although these types of equipment may not require a permit, some may, at the very least, require a construction permit.

Additionally, although a DG unit may be exempt, it may still be necessary to inform the local air agency of the installation of the equipment and projected maximum emissions. However, overall, the permit requirements for diesel emergency generators engines are relatively straightforward.

Emergency generator permit (or exemption) requirements differ throughout the states; they can be based on hp or emissions. For example, some agencies do not require any notification, but documents must be maintained to record the operating hours. Depending on the size and emissions, Colorado and Oklahoma do not require agency notification of installation of exempt equipment.

However, information regarding exempt equipment installed in Arkansas, select counties of North Carolina and Tennessee must be submitted to these agencies. The same equipment located elsewhere may require a permit; this would include agencies such as select counties in North Carolina, select counties in Arizona, and the City of Albuquerque, New Mexico.

For some agencies, rather than a "formal" permit to operate, only a one-time construction approval or registration may be required.

It should be noted that the definition of "emergency" differs from agency to agency, as well. Several agencies use a federal guideline of not more than 500 hrs/yr of operation and less than 5 tons/year that deems an engine as an insignificant activity. Some states may wholly exempt such an engine, while others may require a permit application for installation.

An "emergency" may be limited to true emergencies as a result of a power outage or may allow for some level of peak shaving operations in support of the distribution grid or to take advantage of load shed programs offered by utilities/energy service providers. It is important to clearly understand the operational flexibility and limitations of the "emergency" definition in order to avoid non-compliant operations that can result in an air quality permit violation.

Most recently, the California Air Resources Board has defined diesel particulate exhaust as a carcinogenic air toxic. As a result, a more rigorous evaluation of this exhaust must be undertaken and add-on controls (e.g., catalyst, filter) must be considered in order to eliminate the air quality modeled adverse impact from diesel. Although California is currently the only state that has taken this approach with diesel exhaust, there is the potential that other agencies may shortly follow California's approach.

Gas Engine Installations

For the current generation of lean burn engines, typically the emissions from these engines will meet air agencies' requirements. Likewise, rich burn engines retrofitted with add-on controls (e.g., nonselective catalytic reduction (NSCR) will also meet air agencies' requirements. The range of acceptable NO_x emissions from engines that may trigger control requirements is fairly broad, from 0.15 grams/bhp-hr to 3.0 grams/bhp-hr. State agencies may also impose emission restrictions on CO emissions and VOC emissions.

The primary regulatory consideration with gas engine installations is whether the resulting emissions meet an agency's emission standards. The requirement to meet an emission standard is based on whether the engine itself triggers the regulatory threshold that requires the evaluation of control technology options or best available control technology (BACT), or whether the engine contributes to an emissions increase at the facility/site that requires the evaluation of controls.

If in fact the control technology threshold is triggered, add-on controls may be necessary. If the trigger is an annual basis (e.g., tons/year) a strategy for reducing the permitting burden may be to minimize annual hours of operation in order to eliminate the need for a rigorous control technology evaluation. This applies to both electric generation (solely) and combined heat and power applications.

Microturbine Installations

Microturbines currently range from 30 kW to 300 kW. In California, typically one of the more stringent states with respect to air quality requirements, turbines that are less than 300 kW are exempt from permitting in several local air districts throughout the state.

Therefore, at this time, microturbines are not necessarily required to obtain a Permit to Construct. However, as noted under exempt equipment, it may still be necessary to obtain a construction approval or registration. For agencies that have emission thresholds that dictate whether a permit is needed, depending on the total emissions, a permit may be needed. In order to minimize the permit requirements or qualify for an exemption, limits on the hours of operation may be imposed, thus staying below the permit threshold.

It should be noted that there are on-going efforts to "pre-certify" this type of equipment, e.g., low-emitting, exempt operation, in order to eliminate the uncertainty of permit approval requirements or to eliminate air quality permitting altogether.

At this time, the aggregation of microturbines at one site may still be considered exempt as long as each unit is below the exemption threshold. However, if an agency has a policy (or rule) that requires permitting based on "project emissions" impacts, some level of review and/or permitting may be required (as discussed above).

If, however, several microturbines were deployed throughout an air agency's jurisdiction at different customer sites, each turbine would maintain its exempt status. Because of the concern for cumulative emissions from the potential deployment of multiple microturbines, some agencies are further reviewing whether air quality rules should address this type of deployment.

Agencies' concerns include the more localized impacts because of the proximity of emissions exhaust to the public (compared to that of a central power plant), as well as the contribution to ozone precursor emissions (e.g., NO_x, VOC).

Small Industrial Turbine Installation

Small industrial turbines have been used in many applications, e.g., central plants at education institutions, manufacturing facilities, hospitals, and correctional facilities. Permitting of a small turbine is similar to gas engine permitting. Consideration must be given to whether emissions meet an agency's emission standards.

Because a small turbine is typically sited for the capacity of base load operations, there is often the requirement to evaluate BACT such that the total emissions exceed the BACT threshold. As long as the small turbine meets the agency's control requirements, turbine installation is imminent pending the absence of other regulatory hurdles.

Although small turbines are quite different from the larger "frame" type turbines and aeroderivatives, the small turbines are often required to meet the same stringent emission standards as the much larger turbines. In several California agencies as well as other states in nonattainment of the ozone standard, the NO_x standard is 5 ppm NO_x (@ 15% O_2) for larger turbines.

Translating this to a small turbine, a selective catalytic reduction (SCR) unit would be required because small turbine guarantees are currently in the double-digit NO_x ppm level. In many cases, the installation of SCR can present a financial burden (e.g., equipment, installation, operations) such that projects may not go forward.

There has been a recent trend to consider zero ammonia technology (ZAT) for turbine installations. One ZAT technology that is being required for evaluation is $SCONO_x$. Although there are technical limitations (in addition to cost implications) to applying $SCONO_x$ for certain types of turbine applications and operations, at least one agency has required installation of $SCONO_x$ on a small turbine, e.g., Massachusetts Department of Environmental Protection on a Solar Turbine Taurus.

Another ZAT is XONON by Catalytica; this technology is an in-combustion modification. A site in California has a demonstration project incorporating XONON that has been in operation since June of 1999.

Replacement of Existing Boiler Operations with an Internal Combustion Unit

For facilities with existing steam boiler operations, DG units (engines and turbines) are being evaluated in order to directly replace or displace emissions from the existing boiler and provide on-site generation. For a DG unit that directly replaces a boiler that would be permanently shutdown, the emission reductions can be credited to the DG unit's installation.

Therefore, if the boiler emissions are greater than the resulting DG unit's emissions, the permitting effort can be relatively straightforward. For agencies where BACT is triggered based on the overall net emissions increase, this scenario would result in a net reduction and therefore minimize the control technology burden. **Maximizing the creditable emission reductions from the existing operations is key to minimizing the permitting burdens for the new DG unit.**

However, a different permitting scenario may result depending on the boiler's capacity factor. The emissions of a DG unit that replaces an existing less efficient, higher polluting boiler would be compared to the existing boiler's actual, historical emissions.

Therefore, although the boiler may be permitted to emit at a level higher than a DG source's proposed emissions, the DG source may need to evaluate BACT if the resulting net emissions (e.g., difference between the boiler's actual emissions and the DG source's potential emissions) is an increase that triggers the BACT threshold, or even emission offset requirements.

Regardless of the low capacity factor and less efficient boiler operations, credit cannot be take for a more fuel efficient DG source.

At this time, the issue of fuel efficiency has been addressed in boiler operations. Output-based standards (e.g., lb/MW-hr) are being applied. DG advocates, particularly those with combined heat and power applications, are promoting the benefits of output-based standards to serve as the emission standards.

Air agencies are considering this approach; however, for the purposes of NSR permit applicability, the traditional regulatory thresholds remain in units of mass emission rates, e.g., tons/yr, lbs/hr, lbs/day, and it is not expected that, in the near term, the permitting threshold will be revised to reflect output-based standards.

CONCLUSION

Distributed generation sources can be sited, installed and operated. By proper planning, evaluation of economic impacts and facility operations, and compliance with the local agency requirements, approvals can be obtained. Consideration must be given to the numerous siting issues and the roles of multiple regulatory and governmental agencies and the public when planning any DG project installation.

References

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